Biological Assessment Study Report

Dry Auglaize Creek
Laclede County

September 2014 – March 2015

Prepared for:

Missouri Department of Natural Resources
Division of Environmental Quality
Water Protection Program
Water Pollution Control Branch

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Table of Contents

Page

1.0 Introduction 1
- 1.1 Study Area/Justification 1
- 1.2 Purpose 3
- 1.3 Objectives 3
- 1.4 Tasks 3
- 1.5 Null Hypotheses 3

2.0 Methods 5
- 2.1 Study Timing 5
- 2.2 Station Descriptions 5
  - 2.2.1 Dry Auglaize Creek Biological Assessment Sampling Stations 5
  - 2.2.2 Candidate Reference Bioassessment Sampling Stations 5
- 2.3 MoRAP Aquatic Ecological Classification 7
  - 2.3.1 Ecological Drainage Unit 7
  - 2.3.2 Aquatic Ecological Systems 7
  - 2.3.3 Valley Segment Types 8
- 2.4 Land Cover 8
- 2.5 Habitat Assessment 8
- 2.6 Biological Assessment 8
  - 2.6.1 Macroinvertebrate Collection and Analysis 8
- 2.7 Physicochemical Data Collection and Analysis 9
  - 2.7.1 *In situ* Water Quality Measurements 9
  - 2.7.2 Water Chemistry 9
  - 2.7.3 Data Analysis 9
- 2.8 Quality Assurance/Quality Control (QA/QC) 9
  - 2.8.1 Field Meters 9
  - 2.8.2 Biological Samples 10
  - 2.8.3 Biological Data Entry 10
  - 2.8.4 Duplicate Sample Collection 10

3.0 Analyses and Results 10
- 3.1 Land Cover 10
- 3.2 Stream Habitat Assessment 10
- 3.3 Macroinvertebrate Biological Assessment 11
  - 3.3.1 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP) 11
  - 3.3.2 Macroinvertebrate Percent and Community Composition 16
    - 3.3.2.1 Fall 2014 Sampling Season 16
    - 3.3.2.2 Spring 2015 Sampling Season 19
- 3.4 Physicochemical Water Data 21
  - 3.4.1 Stream Discharge 21
  - 3.4.2 Nitrate + Nitrite-N 21
  - 3.4.3 Total Nitrogen 23
  - 3.4.4 Total Phosphorus 23
  - 3.4.5 Turbidity 23

Page
4.0 Data Trends 23
4.1 Macroinvertebrate Biological Assessment 23
4.1.1 MSCI and Biological Metrics 23
4.1.2 Macroinvertebrate Community Composition 24
4.2 Physicochemical Data 25
5.0 Discussion 25
5.1 Hydrology and Land Cover 25
5.2 Stream Habitat 25
5.3 MSCI and Biological Metrics 26
5.4 Macroinvertebrate Community Composition 26
5.5 Nutrient Enrichment Effects 27
6.0 Conclusions 28
7.0 References Cited 29

Tables

Table 1 Physical Characteristics of the Sampling Reaches for Dry Auglaize Creek and the Candidate Reference Streams Based on Values from the MoRAP Valley Segment Types (VST) Geographic Information Systems (GIS) Layer 4
Table 2 Percent Land Cover from MoRAP Thematic Mapper Satellite Data from 2000 to 2004 11
Table 3 Predominant Category Habitat Values, Category Habitat Scores, Total Habitat Scores, and Percent of Reference SHAPP Values from Stream Habitat Assessments for Dry Auglaize Creek Test Stations and the Saline Creek Biological Criteria Reference Station 13
Table 4 Riffle/Pool Ozark/Osage EDU Perennial/Wadeable Biological Criteria, Biological Support Categories, and Macroinvertebrate Stream Condition Index (MSCI) Scores for Samples Collected at Dry Auglaize Creek Test Stations in 2000, 2014, and 2015 14
Table 5 Riffle/Pool Ozark/Osage EDU Perennial/Wadeable Candidate Reference Stream Biological Criteria, Biological Support Categories, and Macroinvertebrate Stream Condition Index (MSCI) Scores for Samples Collected at Dry Auglaize Creek Test Stations in 2000, 2014, and 2015 15
Table 6 Biological Metric Values for Sensitive Taxa at the Biological Criteria Reference Samples and the Dry Auglaize Creek Test Stations, Fall 2014 and Spring 2015 17

Page

Table 7 Percent EPT, Dominant Macroinvertebrate Families, Macroinvertebrate Taxa, and Quantitative Similarity Index (QSI) at the Dry Auglaize Creek Test Stations and Ozark/Osage EDU Biological Criteria Reference Samples, Fall 2000 and 2014 18

Table 8 Percent EPT, Dominant Macroinvertebrate Families, Macroinvertebrate Taxa, and Quantitative Similarity Index (QSI) at the Dry Auglaize Creek Test Stations and Ozark/Osage EDU Biological Criteria Reference Samples, Spring 2000 and 2015 20

Table 9 Physicochemical Variables at the Little Lindley Creek Bioassessment Study Sampling Stations, 2000, 2014, and 2015 Sampling Seasons 22

Figures

Figure 1 Dry Auglaize Creek in the Ozark/Osage EDU, Fall 2014 and Spring 2015 (Impaired section in red) 2

Figure 2 Dry Auglaize Creek Stations, Laclede County, Fall 2014 and Spring 2015 6

Figure 3 Land Cover of the Dry Auglaize Creek Watershed 12

Figure 4 Percent of Taxa by Biotic Index Range, Fall 2014 17

Figure 5 Percent of Taxa by Biotic Index Range, Spring 2015 19

Attachments

Appendix A Fall 2014 Macroinvertebrate Bench Sheets

Appendix B Cover letter dated October 27, 2006, from MDNR WPP to EPA advocating a Permit for the Lebanon Wastewater Treatment Plant in Lieu of a Total Maximum Daily Load for Dry Auglaize Creek (Water Body Identification No. 1145).

1.0 Introduction

At the request of the Missouri Department of Natural Resources (**MoDNR**) Water Protection Program (**WPP**), the Environmental Services Program (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a biological assessment of Dry Auglaize Creek. Dry Auglaize Creek originates in northeastern Lebanon, Missouri, in Laclede County.

A 1.5 mile class "P" section of Dry Auglaize Creek immediately downstream of the Lebanon Wastewater Treatment Facility (**WWTF**) was included on the 2002 303(d) List of Impaired Waters for an "unknown pollutant" (MoDNR 2010). Dry Auglaize Creek was originally placed on the 1998 303(d) List for Biochemical Oxygen Demand (**BOD**) and Non-Filterable Residue (**NFR**).

1.1 Study Area/Justification

Dry Auglaize Creek originates in the town of Lebanon and flows north for 47.3 miles to its confluence with Wet Glaize Creek in Camden County (Figure 1). Dry Auglaize Creek is listed in the Missouri Water Quality Standards (MoDNR 2014a) as a class "P" stream for the first 7.6 miles, class "C" for the next 34.5 miles, and class "P" for the last 5.2 miles. The impaired segment of Dry Auglaize Creek is located within the 7.6 mile class "P" segment, and the designated uses for this segment are "warm water aquatic life protection," "human health/fish consumption," "livestock and wildlife watering," and "class B whole body contact recreation." The impaired segment of Dry Auglaize Creek is also listed in the water quality standards as a losing stream (MoDNR 2014a).

The city of Lebanon historically experienced untreated sewage escaping through manhole covers before it reached the WWTF and bypassing into Dry Auglaize Creek. In late 2003 and early 2004 the city of Lebanon signed a consent decree with U.S. EPA and the State of Missouri with provisions to correct the bypass problems by constructing plant upgrades such as a lift station on Goodwin Hollow and other improvements at the plant (MoDNR 2010). By 2010 the bypass problem had been fixed, and the lift station had been constructed.

A biological assessment study was conducted during the fall and spring 2000 sampling seasons at two sampling stations (MoDNR 2000). The results of the study found the macroinvertebrate community was impaired at both stations during both sampling seasons compared to the Ozark/Osage Ecological Drainage Unit (**EDU**) biological criteria (Table 4). Macroinvertebrate Stream Condition Index (**MSCI**) scores ranged from 6 to 12 with lowest scores occurring at the upstream station (Station #2).

Because Dry Auglaize Creek is much smaller than the reference stream segments used to calculate biological criteria thresholds for the Ozark/Osage EDU, the stream was assessed for this study using two sets of biological criteria. Macroinvertebrate samples were first compared to the Ozark/Osage EDU biological criteria for wadeable/perennial streams. The samples were then compared to candidate reference stream criteria that were calculated from six streams that were similar in size to Dry Auglaize Creek (Table 1). The streams used to calculate the candidate reference stream criteria include four streams

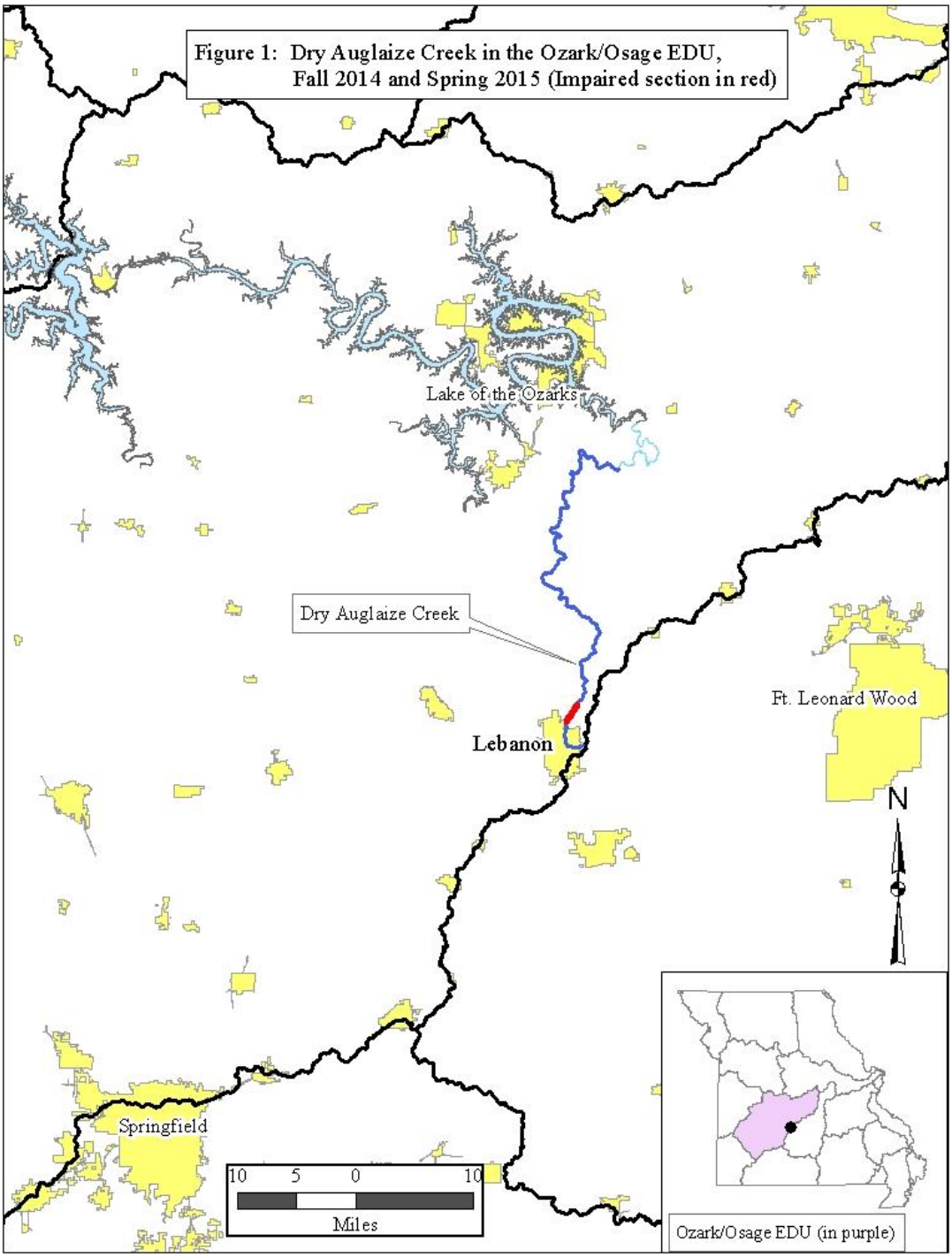


Figure 1: Dry Auglaize Creek in the Ozark/Osage EDU,
Fall 2014 and Spring 2015 (Impaired section in red)
Lake of the Ozarks
Dry Auglaize Creek
Lebanon
Ft. Leonard Wood
N
Springfield
10 5 0 10
Miles
Ozark/Osage EDU (in purple)

(Barren Fork, Deer Creek, Macks Creek, and Starks Creek) that were sampled for the 2002-2003 Little Lindley Creek biological assessment study (MoDNR 2003), one stream (Dry Fork) that was sampled for the 2003-2004 Town Branch/Piper Creek biological assessment study (MoDNR 2005), and Ingalls Creek, a control stream sampled for the 2011-2012 Little Lindley Creek study (MoDNR 2013). The Valley Segment Type (**VST**) five digit codes developed by the Missouri Resource Assessment Program (**MoRAP**) were used in the selection of candidate reference stream segments (Sowa et al. 2004). These streams were chosen from a list of streams that had the same or a very similar five digit VST code as the test streams and had little or no observable water quality problems in their watersheds (Table 1). Candidate reference streams chosen for this study were required to meet the same conditions as biological criteria reference streams as described in *Biological Criteria for Wadeable/Perennial Streams of Missouri* (MoDNR 2002).

1.2 Purpose

The purpose of this study was to determine the present condition of the Dry Auglaize Creek macroinvertebrate community at test stations sampled in 2000 and compare current results to the 2000 study.

1.3 Objectives

1) Determine if the macroinvertebrate community in Dry Auglaize Creek is impaired compared to biological criteria developed from reference stream data in the Ozark/Osage EDU.

2) Determine if the macroinvertebrate community in Dry Auglaize Creek is impaired compared to candidate reference criteria developed in the Ozark/Osage EDU.

3) Determine if the water quality in Dry Auglaize Creek is impaired compared to the Missouri Water Quality Standards (MoDNR 2014a).

4) Assess the habitat quality of Dry Auglaize Creek.

1.4 Tasks

1) Conduct a bioassessment of the macroinvertebrate community on Dry Auglaize Creek at two sampling stations during the fall 2014 and spring 2015 sampling seasons.

2) Collect water samples and water quality field measurements on Dry Auglaize Creek at two sampling stations during the fall 2014 and spring 2015 sampling seasons.

3) Conduct a habitat assessment at the sampling stations to ensure comparability of aquatic habitats.

1.5 Null Hypotheses

1) The macroinvertebrate community will not differ among longitudinally separate reaches of Dry Auglaize Creek.

Table 1
Physical Characteristics of the Sampling Reaches for Dry Auglaize Creek and the Candidate Reference Streams Based on Values from the MoRAP Valley Segment Types (VST) Geographic Information Systems (GIS) Layer

	Dry Auglaize Creek #1	Dry Auglaize Creek #2	Ingalls Creek #1	Dry Fork #1	Starks Creek #1	Macks Creek #1	Barren Fork #1	Deer Creek #1
County	Laclede	Laclede	Hickory	Polk	Hickory	Camden	Miller	Benton
Watershed Area (mi^2)	19.8	12.0	27.4	30.1	35.1	33.7	27.6	63.3
Strahler Order	3	3	3	3	3	4	3	4
Link Magnitude	14	9	19	14	29	26	17	42
VST 5 Digit Code	22221	22241	22122	22122	22121	22122	22121	22121
Temperature Regime	Warm	Warm	Warm	Warm	Warm	Warm	Warm	Warm
Stream Size	Creek	Creek	Creek	Creek	Creek	Creek	Creek	Creek
Flow Regime	Intermittent	Intermittent	Permanent	Permanent	Permanent	Permanent	Permanent	Permanent
Geology	Limestone	Sandstone	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone
Relative Gradient	Low	Low	Medium	Medium	Low	Medium	Low	Low

2) The macroinvertebrate assemblages in the Dry Auglaize Creek samples will be similar to the Ozark/Osage EDU wadeable/perennial stream biological criteria.

3) The macroinvertebrate assemblages in the Dry Auglaize Creek samples will be similar to the Ozark/Osage EDU candidate reference stream criteria.

4) Physicochemical water quality from Dry Auglaize Creek will meet the Water Quality Standards (**WQS**) of Missouri (MoDNR 2014a).

5) Physicochemical water quality will not differ among longitudinally separate reaches of Dry Auglaize Creek.

6) Stream habitat at the Dry Auglaize Creek sampling stations will be similar to Saline Creek, a reference stream in the Ozark/Osage EDU.

2.0 Methods

Carl Wakefield, Mike Irwin, and Raissa Espejo of the Missouri Department of Natural Resources, Division of Environmental Quality, Environmental Services Program, Water Quality Monitoring Section conducted this study.

2.1 Study Timing

Macroinvertebrate and water samples were collected at the Dry Auglaize Creek stations during the fall 2014 and spring 2015 sampling seasons. Fall sampling was conducted on September 25 and 30, 2014, and spring sampling was conducted on March 17, 2015.

2.2 Station Descriptions

Sampling locations for the Dry Auglaize Creek biological assessment study are shown in Figure 2. A total of two Dry Auglaize Creek test stations were surveyed for this study.

2.2.1 Dry Auglaize Creek Biological Assessment Sampling Stations

Dry Auglaize Creek Station #1 – Laclede County: Legal description is NW 1/4 Sec. 31, T. 35 N., R. 15 W. Geographic coordinates are UTM zone 15, 532427 Easting, 4175857 Northing. The sampling station was located upstream of the Iowa Road bridge crossing and 4.75 miles downstream of the Lebanon WWTF outfall.

Dry Auglaize Creek Station #2 – Laclede County: Legal description is N 1/2 Sec. 19, T. 35 N., R. 15 W. Geographic coordinates are UTM zone 15, 532825 Easting, 4179363 Northing. The sampling station was located upstream of the Pacific Drive bridge crossing and 2 miles downstream of the Lebanon WWTF outfall.

2.2.2 Candidate Reference Bioassessment Sampling Stations

Barren Fork #1 – Miller County: Legal description was Sec. 16, T. 39 N., R. 13 W. Geographic coordinates were UTM zone 15, 0556263 Easting, 4218902 Northing.

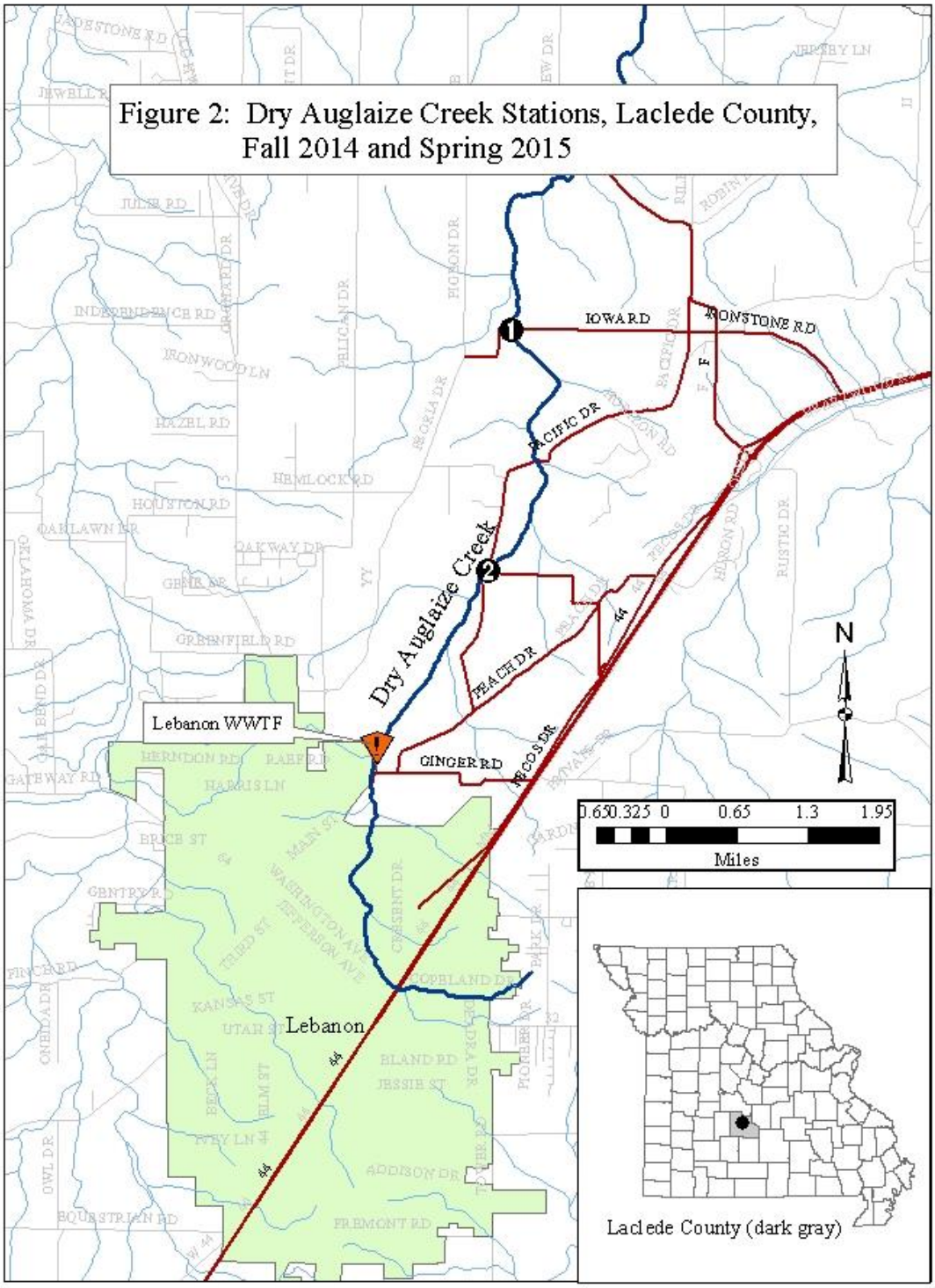


Figure 2: Dry Auglaize Creek Stations, Laclede County, Fall 2014 and Spring 2015
IOWA RD
IRONSTONE RD
PACIFIC DR
Dry Auglaize Creek
PEACH DR
GINGER RD
Lebanon WWTF
Lebanon
N
0.650.325 0 0.65 1.3 1.95
Miles
Laclede County (dark gray)

Deer Creek #1 – Benton County: Legal description was NE ¼ Sec. 30, T. 40 N., R. 20 W. Geographic coordinates were UTM zone 15, 0485011, Easting, 4229279 Northing.

Dry Fork #1 – Polk County: Legal description was SW ¼ Sec. 35, T. 35 N., R. 23 W. Geographic coordinates were UTM zone 15, 0460915, Easting, 4177151 Northing.

Ingalls Creek #1 – Hickory County: Legal description was SE ¼, NW ¼ Sec. 4, T. 35 N., R. 21 W. Geographic coordinates were UTM zone 15, 0477728, Easting, 4184897 Northing.

Macks Creek #1 – Camden County: Legal description was Sec. 29, T. 38 N., R. 19 W. Geographic coordinates were UTM zone 15, 0496640 Easting, 4206301 Northing.

Starks Creek #1 – Hickory County: Legal description was Sec. 23, T. 38. N., R. 20 W. Geographic coordinates were UTM zone 15, 0491250 Easting, 4208246 Northing.

2.3 MoRAP Aquatic Ecological Classification

The aquatic ecological classification developed by MoRAP is a classification system that divides the aquatic resources of Missouri into distinct regions. It has seven levels of classification starting at large regions and then dividing them into smaller sub-regions (Sowa et al. 2004). The following are the seven levels of classification in hierarchical order: zone, subzone, region, aquatic sub-regions, EDU, Aquatic Ecological Systems (**AES**), and Valley Segment Types (**VST**). The levels of classification are based on biology, zoogeography, taxonomic composition, geology, soils, and groundwater connection. Some levels of the hierarchical system use geology and soils to classify, whereas other levels use biology and taxonomic composition of aquatic communities. EDU, AES, and VST are the three levels of classification that will be assessed in detail for this study.

2.3.1 Ecological Drainage Unit

The EDU is level five of the classification hierarchy and is based on geographical variation of the taxonomic composition of the level four sub-regions. An EDU is a region in which aquatic biological communities and habitat conditions can be expected to be similar. Dry Auglaize Creek is located within the Ozark/Osage EDU.

2.3.2 Aquatic Ecological Systems

Aquatic Ecological Systems are level six of the classification hierarchy. They classify aquatic systems based on geology, soils, landform, and groundwater influence. Dry Auglaize Creek is located in the Dry Fork of the Meramec AES type (Sowa and Diamond 2006). This part of the Ozarks is not heavily dissected and consists of gentle slopes that steepen near major drainage divides. Local relief for the Dry Fork of the Meramec AES type is variable and ranges from nearly 50 to 200 feet. Bedrock geology consists of carbonate Ordovician dolomite over which sits residuum made of chert fragments. Surface soil textures consist primarily of silt loams and cherty soils with infiltration rates ranging from very slow to moderate. Floodplains tend to be narrow and streams are often

intermittent or ephemeral in nature. Spring densities are variable, but overall they are not very common and generally have small flows. Historic vegetation consisted of savanna or grassy and oak woodland.

2.3.3 Valley Segment Types

Valley Segment Types are level seven of the classification hierarchy. Stream segments in the GIS stream network layer are classified using a five-digit code. The five-digit VST code is based on temperature regime, stream size, flow regime, geology, and relative gradient. The five-digit VST codes and the values for the five parameters making up the codes can be found in Table 1.

2.4 Land Cover

Land cover percentages were determined using the Missouri portion of the MoRAP Thematic Mapper satellite data from 2000 to 2004. Land cover percentages were determined for the entire Ozark/Osage EDU, the Dry Auglaize Creek test stations, and Saline Creek, a biological criteria reference (**BIOREF**) stream located in Miller County.

2.5 Habitat Assessment

A standardized assessment procedure was followed as described for Riffle/Pool Habitat in the *Stream Habitat Assessment Project Procedure* (**SHAPP**) (MoDNR 2016i). Habitat assessments were conducted at the two Dry Auglaize Creek test stations and the Saline Creek BIOREF station on September 25 and 30, 2014.

2.6 Biological Assessment

Biological assessments consisted of macroinvertebrate collection and physicochemical sampling for the two sample periods.

2.6.1 Macroinvertebrate Collection and Analysis

A standardized macroinvertebrate sample collection and analysis procedure was followed as described in the *Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure* (**SMSBPP**) (MoDNR 2012a) for riffle/pool (**RP**) streams. Three standard habitats— flowing water over coarse substrate (**CS**), depositional substrate in non-flowing water (**NF**), and rootmat (**RM**)—were collected at the sampling stations.

Macroinvertebrate data were analyzed using three methods. The first analysis was to calculate the Macroinvertebrate Stream Condition Index (**MSCI**) using the four general biological metrics found in the SMSBPP (MoDNR 2002, MoDNR 2012a). These four biological metrics included: 1) Taxa Richness (**TR**);
2) Ephemeroptera/Plecoptera/Trichoptera Taxa (**EPTT**); 3) Biotic Index (**BI**); and
4) Shannon Diversity Index (**SDI**). These individual metrics were scored by comparing them to the biological criteria for perennial/wadeable streams from the Ozark/Osage EDU and combined to form the MSCI. MSCI scores of 16-20 qualify as fully supporting, 10-14 are partially supporting, and 4-8 are considered non-supporting of the protection of warm water aquatic life beneficial use designation as specified in the Missouri Water Quality Standards (MoDNR 2014a).

The second analysis was calculating MSCI scores using macroinvertebrate data collected at candidate reference streams in the Ozark/Osage EDU using the same four metrics listed above. This analysis was conducted to determine the extent to which stream size affected the Dry Auglaize Creek macroinvertebrate community since the test stations were much smaller than the wadeable/perennial BIOREF streams used to calculate biological criteria for the Ozark/Osage EDU.

The third analysis was an evaluation of macroinvertebrate community composition using percent composition of EPTT, sensitive taxa, and dominant macroinvertebrate families and taxa. Comparisons of the macroinvertebrate community of Dry Auglaize Creek and the BIOREF streams also were made.

2.7 Physicochemical Data Collection and Analysis

2.7.1 *In situ* Water Quality Measurements

During each sampling period, *in situ* water quality measurements were collected at each of the bioassessment sampling stations. Field measurements included water temperature (°C) (MoDNR 2016c), dissolved oxygen (mg/L) (MoDNR 2016e), conductivity (µS/cm) (MoDNR 2016d), and pH (MoDNR 2012b).

2.7.2 Water Chemistry

Surface water grab samples were collected and returned for analyses to ESP. Turbidity (NTU) (MoDNR 2016b) was measured and recorded in the ESP WQMS biology laboratory. Water samples were analyzed by ESP's Chemical Analysis Section for total suspended solids, chloride, sulfate, total calcium, total magnesium, total phosphorus, ammonia-N, nitrate+nitrite-N, and total nitrogen. Procedures outlined in *Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations* [Standard Operating Procedure (**SOP**) MDNR-ESP-001 (MoDNR 2016a)] and *Field Sheet and Chain-of-Custody Record* [SOP MDNR-ESP-002 (MoDNR 2014b)] were followed when collecting water quality samples. Stream velocity was measured at each station using a SonTek/YSI FlowTracker Handheld-ADV (Acoustic Doppler Velocimeter). Discharge was calculated per the methods in SOP MDNR-ESP-113, *Flow Measurement in Open Channels* (MoDNR 2015).

2.7.3 Data Analysis

Physicochemical data were examined by analyte to determine whether stations had violations of the Missouri WQS. Sampling stations that had values not in compliance with the WQS or U.S. Environmental Protection Agency (U.S. EPA) recommended reference values will be discussed in the report with possible influences being identified.

2.8 Quality Assurance/Quality Control (QA/QC)

2.8.1 Field Meters

All field meters used to collect water quality parameters were maintained in accordance with the Standard Operating Procedure MDNR-ESP-213, *Quality Control Procedures for Checking Water Quality Field Instruments* (MoDNR 2016g).

2.8.2 Biological Samples

Steps to assure accuracy of organism removal from sample debris were performed consistent with those methods found in the SMSBPP document (MoDNR 2012a). Macroinvertebrates found in samples were identified to the taxonomic levels found in Standard Operating Procedure MDNR-ESP-209, *Taxonomic Levels for Macroinvertebrate Identification* (MoDNR 2016f).

2.8.3 Biological Data Entry

All macroinvertebrate data were entered into the WQMS macroinvertebrate database consistent with the Standard Operating Procedure MDNR-ESP-214, *Quality Control Procedures for Data Processing* (MoDNR 2016h).

2.8.4 Duplicate Sample Collection

Duplicate samples are collected at two randomly selected sampling stations per season for macroinvertebrates and for 10 percent of water samples. No duplicate samples were collected for this study.

3.0 Analyses and Results

3.1 Land Cover

Land cover at the Dry Auglaize Creek test stations was higher for impervious surface, low intensity urban, and grassland, but was lower for forest than the values for the entire Ozark/Osage EDU and the Saline Creek biological BIOREF sampling reach (Table 2 and Figure 3). Saline Creek, a biological criteria reference stream in the Ozark/Osage EDU, was used to compare stream habitat and land cover of the test stations to reference conditions.

3.2 Stream Habitat Assessment

Table 3 provides habitat assessment scores for the Dry Auglaize Creek test stations and the Saline Creek BIOREF station. SHAPP guidance states that test stations scoring at least 75 percent of the total score of a reference station should support a similar biological community. Because the Dry Auglaize Creek stream habitat assessment scores were $\geq$75 percent of the reference scores, test stations should be capable of supporting a similar macroinvertebrate community.

Many of the Dry Auglaize Creek habitat metrics scores were either in the optimal or suboptimal range, indicating good habitat quality. Some metrics, however, did not score as well at the Dry Auglaize Creek test stations. At station #1, sediment deposition, channel flow status, riffle quality, and right bank riparian zone width scored in the marginal category; left bank riparian zone width and vegetative protection for both banks scored in the poor category. The results for these habitat metrics led to a much lower habitat score compared to the station #2 and the Saline Creek scores. Station #1 was located in a pasture, and there was visual evidence that the cattle were affecting the stream banks. Station #2 had fewer metrics that scored in the marginal or poor categories, which led to a higher habitat score at that station. Station #2 vegetative protection scored

in the marginal category for both banks, and sediment deposition scored in the poor category.

3.3 Macroinvertebrate Biological Assessment

3.3.1 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP)

MSCI scores were calculated for Dry Auglaize Creek test stations using riffle/pool perennial/wadeable biological criteria and candidate reference criteria for the Ozark/Osage EDU (Tables 4 and 5). Both datasets resulted in identical MSCI scores. Both Dry Auglaize Creek test stations had partially supporting MSCI scores of 10 during both sampling seasons. Three of the biological metrics (TR, BI, and SDI) scored in the partially supporting range, and EPTT scored in non-supporting range during both sampling seasons.

Table 2
Percent Land Cover from MoRAP Thematic Mapper Satellite Data from 2000 to 2004

Land Cover	Ozark/Osage EDU	Saline Creek BIOREF Reach	Dry Auglaize Creek #1	Dry Auglaize Creek #2
Impervious	1.2	1.5	6.2	9.6
High Intensity Urban	0.0	0.1	0.3	0.6
Low Intensity Urban	1.0	0.6	8.5	13.8
Barren/Sparsely Vegetated	0.5	<0.1	0.9	0.7
Cropland	4.8	1.6	2.4	3.4
Grassland	43.0	35.0	51.5	47.1
Deciduous Forest	38.6	56.7	22.5	16.6
Evergreen Forest	1.4	1.4	0.3	0.3
Deciduous Woody/Herbaceous	4.8	1.2	6.7	7.4
Woody Dominated Wetland	0.7	1.1	<0.1	<0.1
Herbaceous-Dominated Wetland	0.2	<0.1	<0.1	<0.1
Open Water	3.7	0.9	0.6	0.5

Figure 3
Land Cover of the Dry Auglaize Creek Watershed

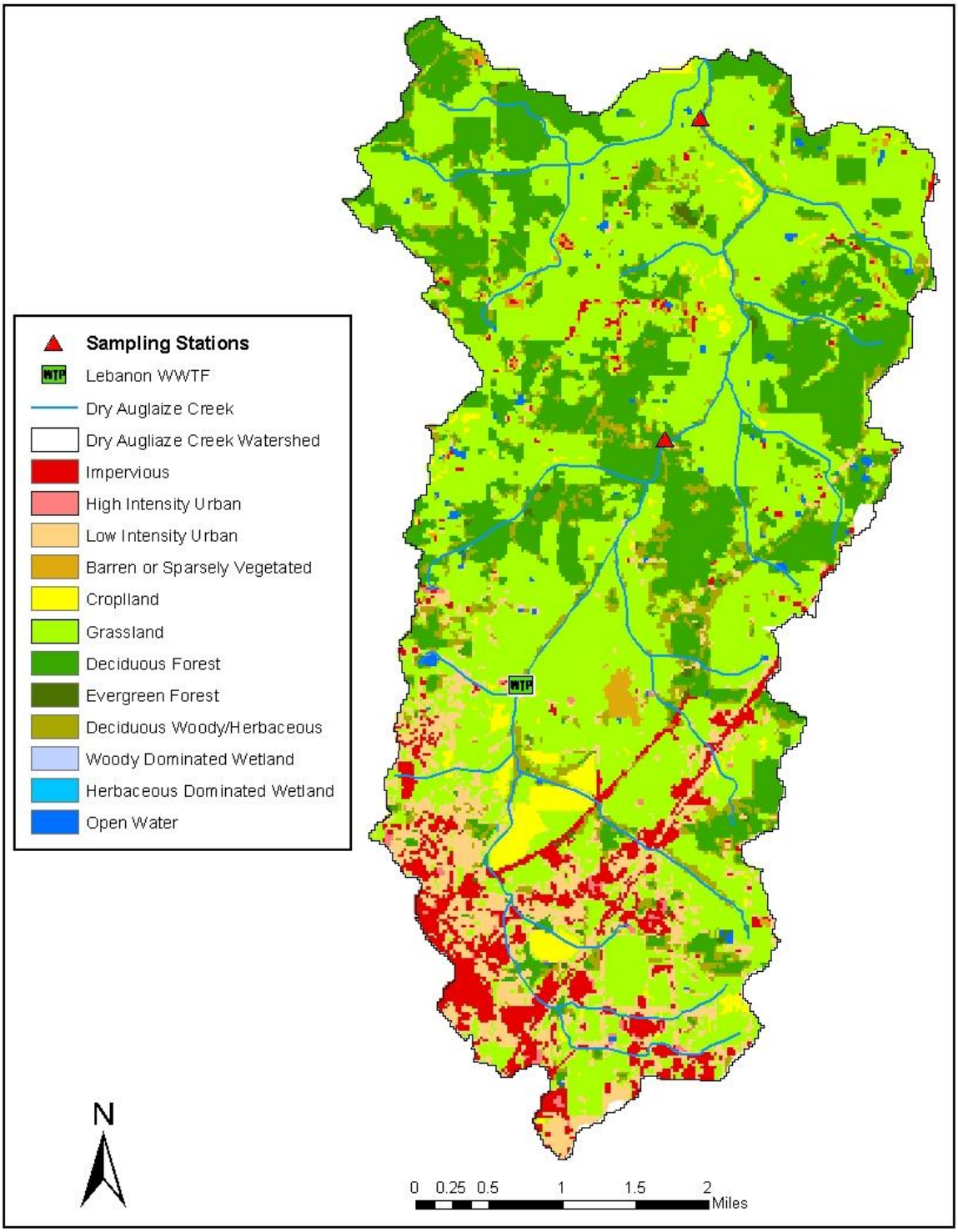


Table 3
Predominant Category Habitat Values, Category Habitat Scores, Total Habitat Scores, and Percent of Reference SHAPP Values from Stream Habitat Assessments for Dry Auglaize Creek Test Stations and the Saline Creek Biological Criteria Reference Station

Stream Habitat Parameters	Dry Auglaize Creek #1	Dry Auglaize Creek #2	Saline Creek
Macroinvertebrate Sample Number	14944	14946	--
Stream Habitat Assessment Date	09/25/2014	09/30/2014	09/30/2014
Epifaunal Substrate/Available Cover	II (13)	II (12)	II (12)
Embeddedness	II (14)	II (13)	II (14)
Velocity/Depth Regime	II (13)	II (15)	II (15)
Sediment Deposition	III (8)	IV (5)	II (12)
Channel Flow Status	III (8)	II (13)	III (6)
Channel Alteration	I (16)	II (15)	I (18)
Riffle Quality	III (8)	II (12)	III (8)
Bank Stability – Left Bank	II (7)	I (9)	III (4)
Bank Stability – Right Bank	I (9)	II (7)	I (10)
Vegetative Protection – Left Bank	IV (1)	III (5)	III (3)
Vegetative Protection – Right Bank	IV (2)	III (3)	IV (1)
Riparian Zone Width – Left Bank	IV (1)	I (9)	I (10)
Riparian Zone Width – Right Bank	III (5)	I (10)	I (10)
Total Habitat Score	**105**	**128**	**123**
Percent of Reference SHAPP	**85.4**	**104.1**	--

Habitat parameter categories range from I to IV with category I = optimal, category II = suboptimal, category III = marginal, and category IV = poor. Habitat parameter scores are listed in parentheses and range from 0 to 20 except for vegetative protection and riparian zone categories, which range from 0 to 10.

Table 4
Riffle/Pool Ozark/Osage EDU Perennial/Wadeable Biological Criteria, Biological Support Categories, and Macroinvertebrate Stream Condition Index (MSCI) Scores for Samples Collected at Dry Auglaize Creek Test Stations in 2000, 2014, and 2015

Station	Sample Year	Sample No.	TR	EPTT	BI	SDI	MSCI	Support
Fall Sampling Season								
Dry Auglaize Creek #1	2000	0020220	57 (3)	11 (3)	7.3 (3)	2.77 (3)	12	P
	2014	14944	53 (3)	6 (1)	7.3 (3)	2.59 (3)	10	P
Dry Auglaize Creek #2	2000	0020221	37 (1)	7 (1)	7.3 (3)	2.31 (3)	8	N
	2014	14946	49 (3)	6 (1)	6.9 (3)	2.72 (3)	10	P
Metric Score=5	If		>84	>19	<6.6	>3.23	20-16	**F**ull
Metric Score=3	If		84-42	19-9	6.6-8.3	3.23-1.61	14-10	**P**artial
Metric Score=1	If		<42	<9	>8.3	<1.61	8-4	**N**on
Spring Sampling Season								
Dry Auglaize Creek #1	2000	0010192	55 (3)	4 (1)	6.9 (3)	2.03 (3)	10	P
	2015	15092	56 (3)	5 (1)	6.7 (3)	2.34 (3)	10	P
Dry Auglaize Creek #2	2000	0010193	37 (1)	3 (1)	6.8 (3)	1.43 (1)	6	N
	2015	15091	53 (3)	7 (1)	7.0 (3)	2.32 (3)	10	P
Metric Score=5	If		>90	>22	<6.2	>3.24	20-16	**F**ull
Metric Score=3	If		90-45	22-11	6.2-8.1	3.24-1.62	14-10	**P**artial
Metric Score=1	If		<45	<11	>8.1	<1.62	8-4	**N**on

Table 5
Riffle/Pool Ozark/Osage EDU Perennial/Wadeable Candidate Reference Stream Biological Criteria, Biological Support Categories, and Macroinvertebrate Stream Condition Index (MSCI) Scores for Samples Collected at Dry Auglaize Creek Test Stations in 2000, 2014, and 2015

Station	Sample Year	Sample No.	TR	EPTT	BI	SDI	MSCI	Support
Fall Sampling Season								
Dry Auglaize Creek #1	2000	0020220	57 (3)	11 (3)	7.3 (3)	2.77 (3)	12	P
	2014	14944	53 (3)	6 (1)	7.3 (3)	2.59 (3)	10	P
Dry Auglaize Creek #2	2000	0020221	37 (1)	7 (1)	7.3 (3)	2.31 (3)	8	N
	2014	14946	49 (3)	6 (1)	6.9 (3)	2.72 (3)	10	P
Metric Score=5	If		>78	>20	<6.0	>3.06	20-16	**F**ull
Metric Score=3	If		78-39	20-10	6.0-8.0	3.06-1.53	14-10	**P**artial
Metric Score=1	If		<39	<10	>8.0	<1.53	8-4	**N**on
Spring Sampling Season								
Dry Auglaize Creek #1	2000	0010192	55 (3)	4 (1)	6.9 (3)	2.03 (3)	10	P
	2015	15092	56 (3)	5 (1)	6.7 (3)	2.34 (3)	10	P
Dry Auglaize Creek #2	2000	0010193	37 (1)	3 (1)	6.8 (3)	1.43 (1)	6	N
	2015	15091	53 (3)	7 (1)	7.0 (3)	2.32 (3)	10	P
Metric Score=5	If		>94	>24	<5.9	>3.27	20-16	**F**ull
Metric Score=3	If		94-47	24-12	5.9-7.9	3.27-1.64	14-10	**P**artial
Metric Score=1	If		<47	<12	>7.9	<1.64	8-4	**N**on

3.3.2 Macroinvertebrate Percent and Community Composition

The percent composition of sensitive taxa, EPTT, and the five dominant macroinvertebrate families and taxa at each station are presented in Tables 6-8 and Figures 3 and 4. Values in bold type represent the five dominant macroinvertebrate families and taxa for each station.

3.3.2.1 Fall 2014 Sampling Season

Percent Composition of Sensitive Taxa

Compared to the BIOREF data, Dry Auglaize Creek samples had a higher percentage of taxa with biotic index values above 5.0 (Figure 4 and Table 6). Taxa that are considered to be more sensitive were less abundant in the Dry Auglaize Creek samples compared to BIOREF samples. The combined percentage for very sensitive taxa (BI <2.5) and sensitive (2.5-4.9) was 2.7 percent at test station #1 and 1.2 percent at station #2. By comparison, the combined percentage of sensitive and very sensitive taxa was 20.7 percent for BIOREF stream samples.

Macroinvertebrate Community Composition

During the fall 2014 sampling season, there were differences in macroinvertebrate taxa composition and abundance between the two test stations and the BIOREF streams (Table 7). Percent EPTT, Ephemeroptera, and Trichoptera were higher at test station #1 but were lower at test station #2 compared to Ozark/Osage EDU BIOREF conditions. The dominant Ephemeroptera and Trichoptera taxa were the same for both test stations but the mayflies *Caenis latipennis* and *Baetis* and the caddisfly *Cheumatopsyche* were much more abundant at test station #1. By comparison, *C. latipennis*, *Cheumatopsyche*, heptageniid mayflies, and *Tricorythodes* were the most abundant EPTT taxa found in the BIOREF streams. Both heptageniid mayflies and *Tricorythodes* either were not abundant or were not present at the test stations.

Other differences between stations included a higher abundance of chironomids at test station #2, higher planarian and tubificid abundance at test station #1, and higher abundance of the amphipod *Hyalella azteca* at the BIOREF streams. The much higher chironomid abundance at test station #2 was primarily made up of *Tanytarsus*, *Rheotanytarsus*, and *Cricotopus/Orthocladius* group, which were much more abundant compared to test station #1 and reference conditions. Biotic index values for a majority of the dominant taxa from the Dry Auglaize Creek test stations were in the moderately tolerant range (BI = 5.0-7.4). Exceptions were *C. latipennis*, Planariidae, and Tubificidae, which were either in the tolerant range (BI = 7.5-8.9) or very tolerant range (BI >8.9).

Figure 4
Percent of Taxa by Biotic Index Range, Fall 2014

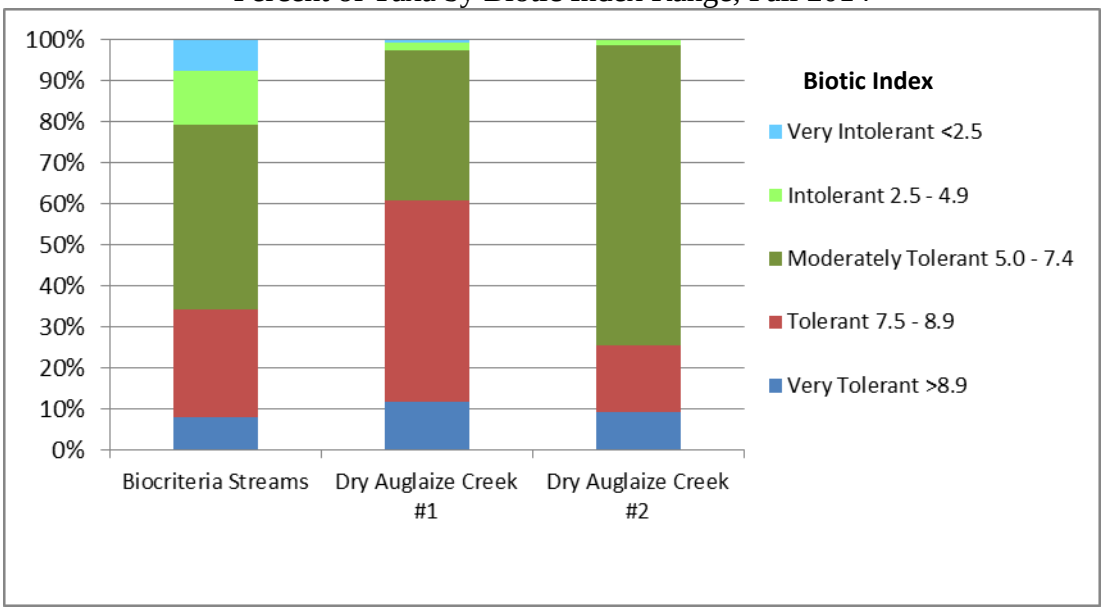


Table 6
Biological Metric Values for Sensitive Taxa at the Biological Criteria Reference Samples and the Dry Auglaize Creek Test Stations, Fall 2014 and Spring 2015

Variable-Station	Biocriteria Reference Data	Dry Auglaize Creek #1	Dry Auglaize Creek#2
Fall 2014			
Sample Number		14944	14946
Sensitive Taxa			
% BI >8.9	8.2	11.7	9.3
% BI 7.5-8.9	26.1	49.2	16.4
% BI 5.0-7.4	44.9	36.4	73.1
% BI 2.5-4.9	13.1	2.1	1.2
% BI <2.5	7.6	0.6	--
Spring 2015			
Sample Number		15092	15091
% BI >8.9	7.4	2.5	2.9
% BI 7.5-8.9	19.3	41.8	11.8
% BI 5.0-7.4	42.6	53.0	84.4
% BI 2.5-4.9	22.2	2.5	0.8
% BI <2.5	8.4	0.2	0.2

Table 7
Percent EPT, Dominant Macroinvertebrate Families, Macroinvertebrate Taxa, and Quantitative Similarity Index (QSI) at the Dry Auglaize Creek Test Stations and Ozark/Osage EDU Biological Criteria Reference Samples, Fall 2000 and 2014

Variable-Station	**Biotic Index**	**Biocriteria Reference Streams**	**Dry Auglaize Creek #1**		**Dry Auglaize Creek #2**	
Sample Number			0020220	14944	0020221	14946
Sample Year			2000	2014	2000	2014
EPT Metrics						
% EPT		41.9	43.5	51.9	60.9	16.6
% Ephemeroptera		34.6	21.3	36.8	30.5	8.0
% Plecoptera		0.7	--	--	--	--
% Trichoptera		6.6	22.2	15.1	30.4	8.6
Percent Dominant Families						
Chironomidae		**21.2**	**9.0**	**14.4**	**9.2**	**59.9**
Caenidae		**11.6**	**16.9**	**28.1**	**26.3**	**6.6**
Heptageniidae		**10.0**	1.2	1.5	--	--
Elmidae		**7.7**	4.0	1.4	0.1	0.5
Leptohyphidae		**7.3**	0.3	**--**	--	**--**
Hydropsychidae		3.4	**22.0**	**14.7**	**30.3**	**7.9**
Coenagrionidae		4.1	**14.1**	4.5	**7.2**	**3.6**
Physidae		0.5	**7.1**	2.9	**8.1**	1.0
Planariidae		0.4	4.1	**13.8**	1.4	2.5
Baetidae		1.7	2.9	**7.2**	4.2	1.3
Tubificidae		2.5	0.9	6.2	1.1	**5.3**
Percent Dominant Taxa						
Trichorythodes	5.4	**7.2**	0.3	--	--	--
Caenis latipennis	7.6	**6.8**	**16.9**	**28.0**	**26.3**	**6.6**
Hyalella azteca	7.9	**6.5**		--		**--**
Tanytarsus	6.7	**3.9**	2.8	2.4	0.3	**16.4**
Cheumatopsyche	6.6	**3.6**	**21.9**	**14.5**	**29.5**	**7.2**
Argia	8.7	1.6	**7.4**	3.8	3.3	2.3
Physella	9.1	0.5	**7.1**	2.9	**8.1**	1.0
Enallagma	9.0	2.4	**6.7**	0.7	**3.9**	1.3
Planariidae	7.5	0.4	4.1	**13.8**	1.4	2.5
Baetis	6.0	1.1	2.7	**7.2**	3.9	1.1
Tubificidae	9.2	2.0	0.9	**5.6**	1.1	4.2
Ancylidae	7.1	1.1	3.4	0.2	**6.0**	3.0
Rheotanytarsus	6.4	1.8	1.6	3.3	3.5	**27.3**
Cricotopus/Orthocladius grp.	6.5	0.7	0.5	1.8	1.1	**4.7**
Quantitative Similarity Index (QSI)			57.9		35.7	

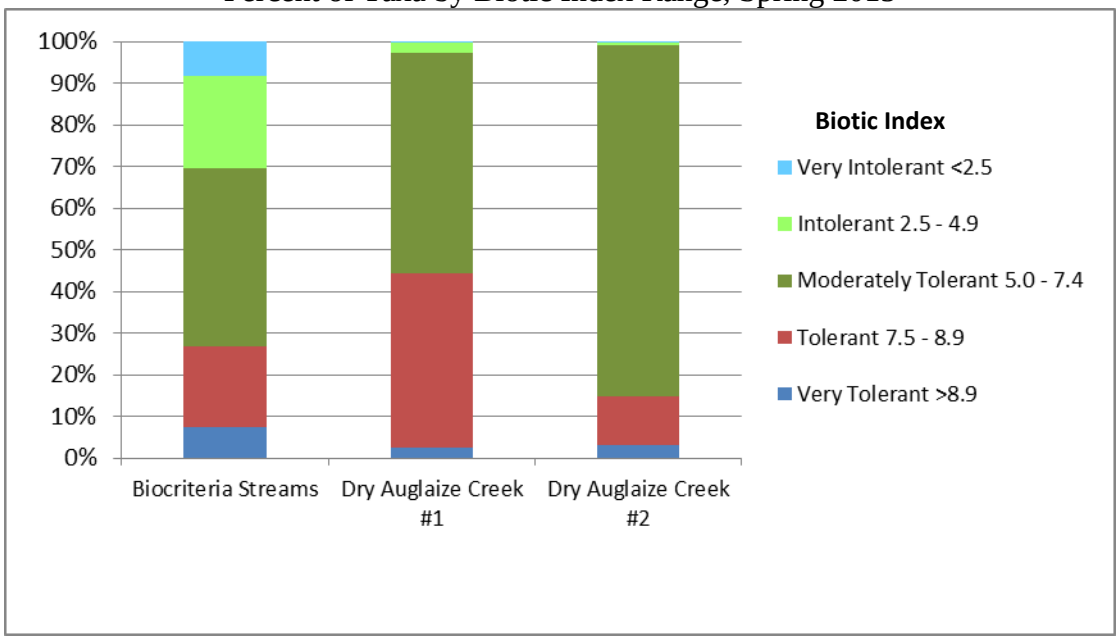
Biocriteria reference stream data values are average percent (n = 28).
Values in bold type represent the five dominant macroinvertebrate dominant taxa for each station.

3.3.2.2 Spring 2015 Sampling Season

Percent Composition of Sensitive Taxa

Dry Auglaize Creek samples had a higher percentage of taxa with biotic index values above 5.0 than the BIOREF streams (Table 6 and Figure 5). Taxa with lower biotic index values, which are considered to be more sensitive, were not abundant in Dry Auglaize Creek samples. The combined percentage for very sensitive (BI <2.5) and sensitive (2.5-4.9) taxa was 2.7 percent at test station #1 and 1.0 percent at station #2, which was much lower than the BIOREF value of 30.6 percent.

Figure 5
Percent of Taxa by Biotic Index Range, Spring 2015



Macroinvertebrate Community Composition

Like the fall 2014 sampling season, there were differences in macroinvertebrate taxa composition and abundance between the two test stations and the BIOREF streams during the spring 2015 sampling season (Table 8). Percent EPTT and Ephemeroptera were higher at test station #1 but were lower at test station #2 compared to Ozark/Osage EDU BIOREF conditions. The mayfly *C. latipennis* made up most of the higher percentage for EPTT and Ephemeroptera at test station #1. Although *C. latipennis* was among the dominant taxa at station #2, it made up a much smaller percentage of the sample compared to station #1. Trichoptera abundance was similar at the test stations compared to BIOREF conditions. Stoneflies made up 7.2 percent of BIOREF samples, but they were absent from Dry Auglaize Creek. Caenid mayflies, heptageniid mayflies, and perlid stoneflies were the most abundant EPTT found in BIOREF streams. Heptageniid mayflies were not abundant in samples, and perlid stoneflies were absent from the test stations. Even though *C. latipennis* was abundant in the Dry Auglaize Creek samples, Chironomidae was the most abundant family found in the samples, especially at test station #2. Chironomid abundance was higher than reference

Table 8
Percent EPT, Dominant Macroinvertebrate Families, Macroinvertebrate Taxa, and Quantitative Similarity Index (QSI) at the Dry Auglaize Creek Test Stations and Ozark/Osage EDU Biological Criteria Reference Samples, Spring 2000 and 2015

Variable-Station	**Biotic Index**	**Biocriteria Reference Streams**	**Dry Auglaize Creek #1**		**Dry Auglaize Creek #2**	
Sample Number			0010192	15092	0010193	15091
Sample Year			2000	2015	2000	2015
EPT Metrics						
% EPT		29.4	24.9	38.7	10.0	9.7
% Ephemeroptera		19.7	22.2	36.0	5.3	6.9
% Plecoptera		7.1	--	--	--	--
% Trichoptera		2.6	2.7	2.7	4.7	2.8
Percent Dominant Families						
Chironomidae		**46.7**	**52.3**	**56.6**	**73.3**	**82.4**
Caenidae		**7.8**	**21.9**	**34.5**	**5.3**	**6.9**
Heptageniidae		**4.5**	0.2	**1.5**	--	L/R
Hyalellidae		**4.4**	0.6	--	1.8	--
Perlidae		**3.4**	**--**	--	--	--
Psephenidae		0.6	**5.3**	0.1	0.7	0.1
Coenagrionidae		0.7	**4.2**	0.6	1.2	0.7
Physidae		0.4	**3.9**	0.2	**4.2**	0.4
Hydropsychidae		0.6	2.7	**2.4**	**4.2**	**2.7**
Tubificidae		2.7	0.2	**1.7**	0.3	**1.7**
Hydrophilidae		0.2	2.2	--	**2.5**	0.1
Ancylidae		0.2	1.8	0.3	1.5	**1.5**
Percent Dominant Taxa						
Cricotopus/Orthocladius grp	6.5	**13.9**	**45.6**	**21.3**	**70.4**	**22.9**
Eukiefferiella	4.0	**6.9**	**--**	--	--	--
Caenis latipennis	7.6	**5.1**	**21.9**	**34.5**	**5.3**	**6.9**
Hyalella azteca	7.9	**4.3**	0.6	--	1.8	--
Tanytarsus	6.7	**3.7**	0.3	**9.4**	--	**17.7**
Ectopria nervosa	4.3	0.1	**5.1**	0.1	0.7	0.1
Physella	9.1	0.3	**3.9**	0.2	**4.2**	0.4
Cheumatopsyche	6.6	0.6	**2.7**	2.3	**4.2**	2.7
Rheotanytarsus	6.4	0.7	0.1	**4.6**	0.3	**24.8**
Corynoneura	6.2	0.5	0.3	**4.5**	--	0.1
Berosus	8.6	0.2	2.2	--	**2.5**	0.1
Phaenopsectra	6.2	0.3	--	3.5	--	**4.6**
Quantitative Similarity Index (QSI)			51.7		35.2	

Biocriteria reference stream data values are average percent (n = 40).
Values in bold type represent the five dominant macroinvertebrate dominant taxa for each station.
L/R represents taxa found only in large/rare part of the sample.

conditions. C*ricotopus/Orthocladius* group made up a little over 20 percent of samples for both test stations, but the higher abundance of chironomids at test station #2 was caused primarily by much higher abundance of *Tanytarsus* and *Rheotanytarsus*. Other chironomid taxa that were abundant at the test stations were *Corynoneura* at test station #1 and *Phaenopsectra* at test station #2. Two of the chironomid taxa common at the test stations, C*ricotopus/Orthocladius* group and *Tanytarsus,* also were abundant in BIOREF stations. However, a more sensitive chironomid that tends to be abundant among BIOREF samples (*Eukiefferiella*) was not found in the test stations. *H. azteca*, which was also common in the BIOREF streams, was absent from Dry Auglaize Creek 2015 samples. Biotic index values for most of the dominant taxa from the Dry Auglaize Creek test stations were in the moderately tolerant range (BI = 5.0-7.4). The only exception was *C. latipennis*, which was in the tolerant range (BI = 7.5-8.9).

3.4 Physicochemical Water Data

Water samples and field measurements were collected during the fall 2014 and spring 2015 macroinvertebrate sampling periods (Table 9). Results showed that nutrient concentrations and turbidity were elevated compared to the U.S. EPA Nutrient Criteria recommended reference values for the Level III Ozark Highlands ecoregion (U.S. EPA 2000). Physicochemical results are arranged to demonstrate trends of certain variables that may suggest a source of effects at Dry Auglaize Creek test stations. Results shown here are for stream discharge, nitrate + nitrite-N, total nitrogen, total phosphorus, and turbidity by season.

3.4.1 Stream Discharge

Discharge at Dry Auglaize Creek test stations was 1.5 cfs at station #1 and 2.8 cfs at station #2 (Table 9) during the fall 2014 sampling season. During the spring 2015 sampling season, discharge was higher with a value of 5.4 cfs at test station #1 and 6.8 cfs at test station #2.

3.4.2 Nitrate + Nitrite-N

During the fall 2014 sampling season, Dry Auglaize Creek samples had nitrate + nitrite-N concentrations above the U.S. EPA recommended reference value (0.24 mg/L) for the Level III Ozark Highlands ecoregion (U.S. EPA 2000). Dry Auglaize Creek nitrate + nitrite-N concentration was 6.84 mg/L at test station #1 and 9.00 mg/L at test station #2 (Table 9).

Spring 2015 nitrate + nitrite-N concentrations were lower than fall 2014 values, but they were still higher than the U.S. EPA recommended reference value (Table 10). The Dry Auglaize Creek nitrate + nitrite-N concentration was 2.50 mg/L at test station #1 and 2.65 mg/L at test station #2.

Table 9
Physicochemical Variables at the Dry Auglaize Creek Bioassessment Study Sampling Stations, 2000, 2014, and 2015 Sampling Seasons

	Dry Auglaize Creek #1		**Dry Auglaize Creek #2**	
Fall Sampling Season				
Sample Number	0007118	1411956	0007119	1412171
Sample Date	09/25/2000	09/25/2014	09/25/2000	09/30/2014
Sample Time	1230	1245	1445	1230
Ammonia	<0.05[a]	0.06	0.58	0.08
Chloride	52.5	70.0	37.6	64.9
Sulfate	--	20.0	--	16.2
Total Recoverable Calcium	--	45.9	--	47.6
Total Recoverable Magnesium	--	24.5	--	26.0
Hardness as $CaCO_3$	--	216	--	226
Dissolved Oxygen	8.70	11.34	8.3	8.53
Discharge (cfs)	3.5	1.5	4.5	2.8
pH (Units)	7.8	8.6	7.6	8.1
Conductivity (µmhos/cm)	619	619	523	645
Temperature (°C)	15.0	19.9	16.0	20.3
Turbidity (NTU)	**2.50**	**4.29**	**3.18**	**2.05**
Total Suspended Solids	--	7.0	--	<5[a]
Nitrate + Nitrite-N	**9.76**	**6.84[b]**	**7.88**	**9.00**
TKN	<1[a]	--	1.0	--
Total Nitrogen	--	**6.71[c]**	--	**8.89[c]**
Total Phosphorus	**5.57**	**2.75**	**3.28**	**3.10**
Spring Sampling Season				
Physicochemical Sample Number	0007102	151827	0007103	151826
Sample Date	03/15/2000	03/17/2015	03/15/2000	03/17/2015
Sample Time	0930	1305	1230	1150
Ammonia	<0.1[a]	0.07	<0.1[a]	0.46
Chloride	52.6	60.2	47.4	57.0
Sulfate	--	21.5	--	22.0
Total Recoverable Calcium	--	32.8	--	33.8
Total Recoverable Magnesium	--	15.7	--	16.2
Hardness as $CaCO_3$	--	147	--	151
Dissolved Oxygen	12.30	13.61	13.40	11.82
Discharge	2.5	5.4	3.6	6.8
pH (Units)	8.7	8.2	8.8	7.3
Conductivity (µmhos/cm)	504	448	494	454
Temperature (°C)	10.0	14.6	14.0	12.0
Turbidity (NTU)	**2.25**	**5.88**	**2.47**	**6.73**
Total Suspended Solids	--	<5[a]	--	6.0
Nitrate + Nitrite-N	**6.82**	**2.50**	**7.64**	**2.65**
TKN	<1[a]	--	<1[a]	--
Total Nitrogen	--	**2.92[c]**	--	**3.54[c]**
Total Phosphorus	**3.61**	**0.56**	**2.74**	**0.41**

[a]Below detectable limits
[b]Sample was diluted during analysis
[c]Nitrate +Nitrate-N and total nitrogen analyses are determined using different methods and QC are ± 20% of acceptance criteria. Because of different methods used and QC criteria, total nitrogen values can sometimes be lower than Nitrate + Nitrate-N values. Units mg/L unless otherwise noted. Values in bold are elevated compared to water quality standards or U.S. EPA recommended reference condition values

3.4.3 Total Nitrogen

During the fall 2014 sampling season, Dry Auglaize Creek samples had total nitrogen concentrations above the U.S. EPA recommended reference value (0.29 mg/L) for the Level III Ozark Highlands ecoregion (U.S. EPA 2000). The Dry Auglaize Creek total nitrogen concentration was 6.71 mg/L at test station #1 and 8.89 mg/L at test station #2 (Table 9).

Spring 2015 total nitrogen concentrations were lower than fall 2014 values, but they were still higher than the U.S. EPA recommended reference value (Table 10). The Dry Auglaize Creek total nitrogen concentration was 2.92 mg/L at test station #1 and 3.54 mg/L at test station #2.

3.4.4 Total Phosphorus

Total phosphorous in the Dry Auglaize Creek samples was higher than the U.S. EPA recommended reference value (0.007 mg/L) for the Level III Ozark Highlands ecoregion (U.S. EPA 2000) during the fall 2014 sampling season. The Dry Auglaize Creek total phosphorus concentration was 2.75 mg/L at test station #1 and 3.10 mg/L at test station #2 (Table 9).

Spring 2015 total phosphorus concentrations were lower than fall 2014 values, but they were still higher than the U.S. EPA recommended reference value (Table 10). The Dry Auglaize Creek total phosphorus concentration was 0.56 mg/L at test station #1 and 0.41 mg/L at test station #2 (Table 9).

3.4.5 Turbidity

Turbidity in the Dry Auglaize Creek samples was higher than the U.S. EPA recommended reference value (1.43 NTU) for the Level III Ozark Highlands ecoregion (U.S. EPA 2000) during both sampling seasons. Turbidity was 4.29 NTU at test station #1 and 2.05 NTU at test station #2 during the fall 2014 sampling season (Table 9). During the spring 2015 sampling season, turbidity was 5.88 NTU at test station #1 and 6.73 NTU at test station #2.

4.0 Data Trends

4.1 Macroinvertebrate Biological Assessment

4.1.1 MSCI and Biological Metrics

Biological assessment sampling was conducted on Dry Auglaize Creek on September 25, 2000 (MoDNR 2000), shortly after the City of Lebanon was issued a Notice of Violation for wastewater system bypasses that occurred September 9-13 and on September 17, 2000. These bypass events were thought to be the cause of impairment documented in the 2000 biological assessment (Appendix B: October 27, 2006, letter from MoDNR WPP staff to U.S. EPA).

A comparison of MSCI scores between the 2000 study and the current study (2014-2015) showed that there was a slight improvement at test station #2, but not at test station #1 (Tables 4 and 5). During the fall sampling season, the MSCI score at test station #2

improved from a non-supporting score of 8 in 2000 to a partially supporting score of 10 in 2014. The spring sampling season MSCI score at test station #2 improved from a non-supporting score of 6 in 2000 to a partially supporting score of 10 in 2014. Higher TR values during both sampling seasons and SDI during the spring sampling season for the 2014-2015 samples led to slightly higher MSCI scores at test station #2.

At test station #1, MSCI scores were similar during both sampling periods, with a partially supporting score of 10 for most samples. The only exception was that the fall 2000 sample had a partially supporting score of 12. A higher EPTT value during the fall 2000 sampling season led to the slightly higher MSCI score of 12 at test station #1.

4.1.2 Macroinvertebrate Community Composition

In fall 2014 the percent EPTT was slightly higher at test station #1 compared to 2000, but at test station #2 the 2014 percentage was much lower than the 2000 sample (Table 7). Ephemeroptera accounted for most of the higher percent EPTT at test station #1 in 2014, whereas Ephemeroptera and Trichoptera were equally abundant in 2000 at test station #2. A higher abundance of two EPTT taxa, C*heumatopsyche* and *C. latipennis*, led to the much higher percent EPTT in 2000.

Although C*heumatopsyche* and *C. latipennis* were abundant at the two sampling stations during both sampling years, there were some differences in the other dominant taxa between sample stations and sample years. At station #1, *Argia*, *Physella*, and *Enallagma* were more abundant in fall 2000, whereas Planariidae, *Baetis*, and Tubificidae were more abundant in 2014. In addition to *Cheumatopsyche* and *C. latipennis*, other dominant taxa at test station #2 in 2000 included *Physella*, *Enallagma*, and Ancylidae. In the fall 2014 sample, *Rheotanytarsus*, *Tanytarsus*, and *Cricotopus/Orthocladius* group were more abundant at station #2.

During the spring 2015 sampling season, percent EPTT was higher at station #1 compared to 2000, but percentages were about the same between years at test station #2 (Table 8). A higher abundance of Ephemeroptera, primarily *C. latipennis*, led to the higher percent EPTT at test station #1 in 2015. Percent EPTT was much higher during both sampling years at test station #1 compared to test station #2.

Chironomidae was the dominant family at both sampling stations during both years, but it consistently made up a much higher percentage at test station #2. There were, however, differences in the dominant chironomid taxa among test stations and sampling years. *Cricotopus/Orthocladius* group was very abundant at the test stations during both sampling years, but it was much more abundant in 2000. In 2000, chironomid taxa *Rheotanytarsus* and *Tanytarsus* were absent or nearly absent at both test stations, but they were relatively abundant in 2015. *Corynoneura* ranked among the top five taxa in abundance at test station #1 in 2015, but it was rare in 2000. Likewise, *Phaenopsectra* was in the top five abundant taxa in 2015 at test station #2, but it was absent from both stations in 2000. *C. latipennis* was abundant at the two test stations during both sampling years, with values consistently higher at test station #1. Other differences in dominant

taxa between sampling years were a higher abundance of *Ectopria nervosa*, *Physella*, and *Berosus* at test station #1 and a higher abundance of *Physella*, *Cheumatopsyche*, and *Berosus* at test station #2 in 2000 compared to 2015.

The Quantitative Similarity Index (**QSI**) was used to determine the macroinvertebrate community similarity between samples collected in 2000 and samples collected in 2014-2015 (Tables 7 and 8). QSI values were much higher at test station #1 than station #2 during both sampling periods (Tables 10 and 11). At test station #1 the QSI value was 57.9 during the fall sampling season and 51.7 during the spring. By comparison, the QSI was 35.7 at test station #2 during the fall sampling season and 35.2 during the spring. These results indicated that the macroinvertebrate community at test station #1 was more similar between sampling years than test station #2.

4.2 Physicochemical Data

A comparison of water quality data from the 2000 study and the current study showed elevated nutrient concentrations and turbidity values during both sampling periods compared to U.S. EPA Nutrient Criteria recommended reference values for the Level III Ozark Highlands ecoregion (Table 9). The main difference in the nutrient data between the sampling periods was that total phosphorus during both sampling seasons and nitrate + nitrite-N during the spring sampling season were considerably higher in 2000. Whereas spring 2015 turbidity was higher than the 2000 data at both stations, the fall turbidity readings were variable.

5.0 Discussion

5.1 Hydrology and Land Cover

Most of the land cover of Dry Auglaize Creek watershed is rural with grassland being the dominant land cover (Table 2). But the upper part of the watershed, which is located within the Lebanon city limits, had a higher percentage of impervious surface and low intensity urban land cover categories. Percent forest for the Dry Auglaize Creek watershed is much lower than the entire Ozark/Osage EDU and the Saline Creek BIOREF reach. Elevated levels of impervious surface may have altered the hydrology of Dry Auglaize Creek and increased runoff as has been shown in other studies (Lazaro 1990; Paul and Meyer 2001). Dry Auglaize Creek is also classified as a losing stream (MoDNR 2014a), which could also be affecting the hydrology of the stream. This classification also explains why the upstream station had a higher discharge during both sampling seasons in this study.

A study comparing three streams with distinctly different land cover in the Piedmont region of North Carolina found differences in the macroinvertebrate community (Lenat and Crawford 1994). The study found that a stream located in a forested watershed had a much more sensitive macroinvertebrate community with a much higher abundance and diversity of EPTT compared to a stream located in an agricultural watershed and a stream located in an urban watershed. By contrast, the agricultural stream had a much higher abundance of dipteran taxa, especially chironomids, and the urban stream had a higher abundance of oligochaete worms. The elevated agricultural and urban land cover in the

Dry Auglaize Creek watershed compared to reference conditions, in combination with the WWTF effluent, likely influenced the macroinvertebrate community composition since it was primarily made up of moderately tolerant or tolerant taxa.

5.2 Stream Habitat

Stream habitat assessments conducted during the fall 2014 sampling season suggest that the Dry Auglaize Creek test stations should be comparable to Saline Creek, a BIOREF stream, in their ability to support a similar quality macroinvertebrate community (Table 3). Although the overall habitat scores were similar to reference conditions, some of the stream habitat metrics of the SHAPP indicated that habitat could possibly be affecting the macroinvertebrate community. At Dry Auglaize Creek #1, sediment deposition, channel flow status, riffle quality, vegetative protection for both banks, and riparian zone width for both banks scored in the marginal or poor categories. These lower metric scores led to a much lower overall habitat score at this station compared to Dry Auglaize Creek #2 and the Saline Creek BIOREF station. Dry Auglaize Creek #1 was located in a pasture, and there was visual evidence that cattle were affecting stream bank quality. The presence of cattle in the stream also could have led to increased sedimentation and lower riffle quality. Dry Auglaize Creek #2 generally had better habitat conditions with only two categories (sediment deposition and vegetative protection for both banks) having scores in the marginal or poor category.

Other studies have found that increased sediment deposition, suboptimal riffle quality, and suboptimal riparian zone width can have an effect on the macroinvertebrate community composition (Lemly 1982; Zweig and Rabeni 2001). In this study it is difficult to determine if stream habitat had any effect on the macroinvertebrate community because MSCI scores and biological metric values were similar at the two test stations. The only evidence that might indicate that sedimentation may be affecting the macroinvertebrate community was a higher abundance of the chironomid *Stictochironomus* during the spring sampling season and tubificid worms during the fall sampling seasons at test station #1. Both of these taxa were classified as sediment tolerant taxa by Zweig and Rabeni (2001).

5.3 MSCI and Biological Metrics

Macroinvertebrate samples from Dry Auglaize Creek had partially supporting MSCI scores of 10 during both sampling seasons (Tables 4 and 5). There were no differences in MSCI and biological metric scores for the Dry Auglaize Creek samples when compared to the candidate reference and BIOREF datasets. The biological metrics making up the MSCI either scored in the partially supporting range (TR, BI, and SDI) or the non-supporting range (EPTT).

A comparison of the biological metrics between the 2000 study and the current study showed that most of the biological metric values were similar during both sampling periods (Table 4 and 5). In the current study, higher TR values during both sampling seasons and SDI during the spring sampling season led to slightly higher MSCI scores at test station #2. At test station #1, MSCI scores were similar during both sampling

periods with a partially supporting score of 10 for most samples. The only exception was that the fall 2000 sample had a partially supporting MSCI score of 12, which resulted from a higher EPTT value. The overall results of the current study showed that the Dry Auglaize Creek macroinvertebrate community was slightly more diverse at test station #2 compared to the results of the 2000 study.

5.4 Macroinvertebrate Community Composition

The Dry Auglaize Creek macroinvertebrate community was made up of more tolerant taxa than reference conditions based on the results from percent sensitive taxa, percent EPTT, percent Ephemeroptera, and macroinvertebrate community composition. Dry Auglaize Creek samples were primarily made up of moderately tolerant (BI = 5.0-7.4) or tolerant taxa (BI = 7.5-8.9), and the majority of taxa had BI values of 5 or above (Table 6). The proportion of EPTT and Ephemeroptera taxa during both sampling seasons was higher at test station #1 than BIOREF conditions, but these observations were due to the high abundance of the tolerant mayfly *C. latipennis* (Tables 7 and 8). At station #2, percent EPTT and percent Ephemeroptera were much lower than reference conditions. The only other EPTT that was common in Dry Auglaize Creek was the moderately tolerant caddisfly *Cheumatopsyche*. Stoneflies were present in BIOREF samples during both sampling seasons, but they were absent among all Dry Auglaize Creek samples. Chironomids were very abundant at test station #2 during both sampling seasons and at test station #1 during the spring 2015 sampling season. The most common chironomid taxa found in the Dry Auglaize Creek samples had BI values in the moderately tolerant range. These results suggest that the macroinvertebrate community in Dry Auglaize Creek is likely affected by water quality conditions resulting from the Lebanon WWTF effluent. Land cover likely had an effect on the macroinvertebrate community of test station #2, and a combination of effluent, land cover, and stream habitat conditions may have affected the test station #1 community.

5.5 Nutrient Enrichment Effects

Results from the surface water sample analysis showed that nitrate + nitrite-N, total nitrogen, and total phosphorus were elevated compared to U.S. EPA recommended reference values (U.S. EPA 2000). These results were similar to what was found during the earlier biological assessment study in 2000 (Table 14). The main difference in nutrient concentrations between the earlier study and the current study was that total phosphorus, especially during the spring sampling season, was generally higher in 2000. Results for MSCI, the biological metrics, and the high abundance of moderately tolerant or tolerant taxa in Dry Auglaize Creek indicate that nutrient concentrations were having an effect on the macroinvertebrate community. Previous studies have reported declines in EPTT (Dyer and Wang 2002), increases in hydopsychid caddisflies (Suckling 1982), and increases in the nutrient-tolerant chironomids *Dicrotendipes* and *Cricotopus/Orthocladius* group (Jacobsen 2008) below WWTF outfalls.

A study from samples collected in April 2008 on the Blue River, located in the Kansas City metropolitan area, found that EPTT richness, percent shredders, and relative abundance and richness of Plecoptera taxa were higher upstream of a WWTF (Poulton et

al. 2015). Samples downstream of the WWTF had higher values for percent dominant taxa, a higher percent of the two most dominant taxa, a higher percent Hydropsychidae Trichoptera, and higher Kansas Biotic Index (KBI) values from samples that were collected in April 2008. The results for the 2014-2015 Dry Auglaize Creek study found similar results for many of the same metrics. Dry Auglaize EPTT was lower, percent Hydropsychidae Trichoptera (especially during the fall 2014 sampling season) was higher, *Cricotopus/Orthocladius* group (especially during the spring 2015 sampling season) was higher, percent dominant taxa was higher, and biotic index was higher compared to reference conditions (Tables 4, 7, and 8).

6.0 Conclusions

Dry Auglaize Creek MSCI scores indicate that the protection of aquatic life designated use as listed in the Missouri WQS was not being met. Low MSCI scores were likely due to nutrient enrichment at both stations and possible habitat alteration caused by cattle at test station #1. Dry Auglaize is an effluent dominant stream that is classified in the WQS as a losing stream that has little or no flow upstream of the WWTF.

Tests of the null hypotheses resulted in the following conclusions.

1) The macroinvertebrate community will not differ among longitudinally separate reaches of Dry Auglaize Creek. This hypothesis was accepted since the Dry Auglaize Creek test station samples all had MSCI scores in the partially supporting range using Ozark/Osage EDU biological criteria.

2) The macroinvertebrate assemblages in the Dry Auglaize Creek samples will be similar to the Ozark/Osage EDU wadeable/perennial stream biological criteria. This hypothesis was rejected since the Dry Auglaize Creek test stations had MSCI scores that were in the partially supporting range.

3) The macroinvertebrate assemblages in the Dry Auglaize Creek samples will be similar to the Ozark/Osage EDU candidate reference stream criteria. This hypothesis was rejected since the Dry Auglaize Creek test stations had MSCI scores that were in the partially supporting range.

4) Physicochemical water quality from Dry Auglaize Creek will meet the Water Quality Standards (**WQS**) of Missouri (MoDNR 2014a). This hypothesis was accepted since no water quality standards were violated.

5) Physicochemical water quality will not differ among longitudinally separate reaches of Dry Auglaize Creek. This hypothesis was accepted since water constituent results were similar among the Dry Auglaize Creek test stations.

6) Stream habitat at the Dry Auglaize Creek sampling stations will be similar to Saline Creek, a reference stream in the Ozark/Osage EDU. This hypothesis was accepted since the overall stream habitat assessment scores at Dry Auglaize Creek were at least 75

percent of the stream habitat score of Saline Creek, a BIOREF stream in the Ozark/Osage EDU. Even though test station #1 overall stream habitat score was good, it was much lower than test station #2 due to metrics such as sediment deposition, riffle quality, and riparian zone width having scores in the poor or marginal category.

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Appendix A

Macroinvertebrate Bench Sheets

Aquid Invertebrate Database Bench Sheet Report
Dry Auglaize Cr [14944], Station #1, Sample Date: 9/25/2014 12:50:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	1		
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	1	
BASOMMATOPHORA			
Ancylidae	2		
Helisoma	2	1	7
Menetus			7
Physella			37
Planorbella	3		
COLEOPTERA			
Berosus	2	-99	
Dubiraphia			2
Ectopria nervosa	15	2	2
Microcylloepus pusillus	1		1
Stenelmis	12	-99	2
DIPTERA			
Ablabesmyia		2	4
Cricotopus bicinctus	2		
Cricotopus/Orthocladius	23		
Dicrotendipes			1
Diptera			5
Forcipomyiinae	2		
Labrundinia			6
Limonia			1
Nanocladius			1
Paratanytarsus			5
Polypedilum flavum	24		
Polypedilum illinoense grp	17		10
Polypedilum scalaenum grp		1	
Procladius			1
Rheotanytarsus	39		3
Simulium	1		
Stictochironomus		5	
Tanytarsus	7	19	5

Aquid Invertebrate Database Bench Sheet Report
Dry Auglaize Cr [14944], Station #1, Sample Date: 9/25/2014 12:50:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Thienemanniella	7		
Tipula			1
Xenochironomus			1
EPHEMEROPTERA			
Baetis	91		1
Caenis latipennis	34	253	69
Stenonema femoratum	8	9	2
HEMIPTERA			
Belostoma			-99
Rheumatobates			1
LUMBRICINA			
Lumbricina	-99	1	
ODONATA			
Argia	10	1	37
Calopteryx			1
Enallagma			9
Epitheca (Epicordulia)			2
Hetaerina			1
TRICHOPTERA			
Cheumatopsyche	178		6
Chimarra	5		
Hydropsyche	2		
TRICLADIDA			
Planariidae	129	-99	46
TUBIFICIDA			
Aulodrilus			2
Branchiura sowerbyi		4	
Limnodrilus hoffmeisteri			2
Tubificidae	3	34	34
VENEROIDA			
Pisidiidae			2

Aquid Invertebrate Database Bench Sheet Report
Dry Auglaize Cr [14946], Station #2, Sample Date: 9/30/2014 12:35:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	1		
ARHYNCHOBDELLIDA			
Erpobdellidae	1	3	4
BASOMMATOPHORA			
Ancylidae	33	1	6
Helisoma	-99		
Menetus	2		19
Physella		5	8
Planorbella	4		8
COLEOPTERA			
Berosus	2		5
Ectopria nervosa	2		1
Stenelmis	7		
DIPTERA			
Ablabesmyia	1	9	6
Cricotopus bicinctus	5		
Cricotopus/Orthocladius	55		8
Cryptochironomus		1	
Dicrotendipes		1	
Forcipomyiinae	3		
Labrundinia			2
Paratanytarsus		2	4
Phaenopsectra	1	6	1
Polypedilum flavum	51		4
Polypedilum illinoense grp	7		4
Polypedilum scalaenum grp	1	3	1
Procladius		21	5
Rheotanytarsus	331	5	31
Simulium	2		
Tanytarsus	24	147	50
Thienemanniella	13		4
Thienemannimyia grp.	1		

EPHEMEROPTERA			
Apobaetis		3	
Baetis	12		3
Caenis latipennis	17	60	12
HEMIPTERA			
Metrobates	-99		
LUMBRICULIDA			
Lumbriculidae	1		-99
ODONATA			
Argia	4	2	25
Enallagma		1	16
Epitheca (Epicordulia)			1
Epitheca (Tetragoneuria)			-99
Hagenius brevistylus			2
Hetaerina	4		3
RHYNCHOBDELLIDA			
Glossiphoniidae			-99
TRICHOPTERA			
Cheumatopsyche	88		9
Hydropsyche	8		1
Oecetis	8		1
TRICLADIDA			
Planariidae	12	1	21
TUBIFICIDA			
Aulodrilus		9	3
Branchiura sowerbyi			1
Limnodrilus hoffmeisteri		1	
Tubificidae	1	27	29
VENEROIDA			
Pisidiidae	3	7	27

Aquid Invertebrate Database Bench Sheet Report
Dry Auglaize Cr [15092], Station #1, Sample Date: 3/17/2015 1:05:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
BASOMMATOPHORA			
Ferrissia	2	1	1
Helisoma		-99	1
Physella		1	1
COLEOPTERA			
Dubiraphia			2
Ectopria nervosa	1		
Elmidae	2		
Microcylloepus pusillus	1		
Stenelmis	1		2
DECAPODA			
Orconectes punctimanus			-99
DIPTERA			
Ablabesmyia		1	
Ceratopogoninae	1		
Chironomidae	3		
Chironomus		2	
Cladotanytarsus	2		
Corynoneura	9	9	39
Cricotopus/Orthocladius	241	4	27
Cryptochironomus	1	4	
Dicrotendipes	4	6	6
Nanocladius			2
Parametriocnemus	2		
Paraphaenocladius		2	8
Paratanytarsus	7	5	34
Phaenopsectra	17	16	11
Polypedilum flavum	8		
Polypedilum illinoense grp	1		2
Polypedilum scalaenum grp			1
Rheotanytarsus	29	1	28
Simulium	1		2
Stempellinella	1	2	
Stictochironomus	6	32	1

Aquid Invertebrate Database Bench Sheet Report
Dry Auglaize Cr [15092], Station #1, Sample Date: 3/17/2015 1:05:00 PM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Tanytarsus	25	41	54
Thienemanniella	11		15
Tipula			-99
Tribelos	1		
Zavrelimyia		1	
EPHEMEROPTERA			
Caenis latipennis	81	292	67
Heptageniidae	1	5	
Maccaffertium			1
Stenonema femoratum	7	4	1
HEMIPTERA			
Belostoma			-99
ISOPODA			
Lirceus			1
LUMBRICINA			
Lumbricina		-99	1
ODONATA			
Argia	4		1
Enallagma			3
PHARYNGOBDELLIDA			
Hirudinidae		1	1
RHYNCHOBDELLIDA			
Glossiphoniidae		-99	
TRICHOPTERA			
Cheumatopsyche	29		
Hydropsychidae	2		
Hydroptilidae	2		1
TRICLADIDA			
Planariidae	5	2	
TUBIFICIDA			
Branchiura sowerbyi		2	
Limnodrilus hoffmeisteri		2	
Tubificidae	1	13	4

Aquid Invertebrate Database Bench Sheet Report
Dry Auglaize Cr [15091], Station #2, Sample Date: 3/17/2015 11:50:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
ARHYNCHOBDELLIDA			
Erpobdellidae	2	-99	-99
BASOMMATOPHORA			
Ancylidae	26	2	
Gyraulus	1		
Helisoma	-99	-99	-99
Lymnaeidae			1
Menetus	3	1	5
Physella	3	1	4
Planorbella	6		1
COLEOPTERA			
Berosus	2	-99	
Ectopria nervosa			1
DIPTERA			
Ablabesmyia	1	2	1
Chironomidae	1	1	3
Chironomus		1	1
Corynoneura			1
Cricotopus bicinctus	2	1	
Cricotopus trifascia	23		1
Cricotopus/Orthocladius	392	11	26
Cryptochironomus	2	5	
Dicrotendipes	12	7	6
Ephydridae			1
Micropsectra			3
Paraphaenocladius		1	
Paratanytarsus	2		3
Phaenopsectra	27	54	5
Polypedilum flavum	43		12
Polypedilum halterale grp		2	
Polypedilum illinoense grp	2	1	3
Polypedilum scalaenum grp	4	9	
Procladius		2	
Rheotanytarsus	303	23	140

Aquid Invertebrate Database Bench Sheet Report
Dry Auglaize Cr [15091], Station #2, Sample Date: 3/17/2015 11:50:00 AM
CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence

ORDER: TAXA	CS	NF	RM
Simulium	10		
Smittia	1		
Tanytarsus	153	119	60
Thienemanniella	49	5	19
Thienemannimyia grp.			1
Tipula			-99
Tvetenia	1		
EPHEMEROPTERA			
Caenis latipennis	68	46	16
Stenonema femoratum		-99	
GORDIOIDEA			
Chordodidae	-99		
ISOPODA			
Lirceus		1	
LUMBRICINA			
Lumbricina		-99	
ODONATA			
Argia	5	2	3
Calopteryx			1
Enallagma	1		2
Epitheca (Epicordulia)			-99
TRICHOPTERA			
Cheumatopsyche	41	1	8
Hydroptila	1		
Oecetis	2		
TRICLADIDA			
Planariidae	11		1
TUBIFICIDA			
Aulodrilus		1	
Enchytraeidae	2		2
Limnodrilus claparedianus			1
Limnodrilus hoffmeisteri		1	
Tubificidae	8	20	
VENEROIDA			
Pisidiidae	6	2	7

Appendix B

Cover letter dated October 27, 2006, from MDNR WPP to EPA advocating a Permit for the Lebanon Wastewater Treatment Plant in Lieu of a Total Maximum Daily Load for Dry Auglaize Creek (Water Body Identification No. 1145).

STATE OF MISSOURI Matt Blunt, Governor • Doyle Childers, Director
DEPARTMENT OF NATURAL RESOURCES
www.dnr.mo.gov

OCT 27 2006

Mr. John DeLashmit
U.S. Environmental Protection Agency
Region VII
901 North Fifth Street
Kansas City, KS 66101

RE: Permit for Lebanon Wastewater Treatment Plant in Lieu of a Total Maximum Daily Load for Dry Auglaize Creek (Water Body Identification No. 1145)

Dear Mr. DeLashmit:

Dry Auglaize Creek near Lebanon, in Laclede County, is on Missouri's 2002 303(d) List for "unknown pollutant" and the source is listed as the Lebanon Wastewater Treatment Plant (WWTP), Missouri State Operating Permit Number MO-0089010. The original pollutants listed on the 1998 303(d) List were Biological Oxygen Demand (BOD) and Non-Filterable Residue (NFR) because of algae and reduced aquatic invertebrate populations downstream of the WWTP. The Department of Natural Resources (department) believes that the original designation of pollutants is correct, however, the source is not the Lebanon WWTP itself, but rather the *bypassing* of the plant. Bypassing from manholes results in wastewater being released before it can be treated.

The city has a history of violations for sanitary sewer overflows (SSOs), particularly at Manhole #1, located 100 yards upstream (south) of the WWTP. In lieu of a Total Maximum Daily Load (TMDL), the department has opted to correct these impairments through permit limits and a schedule for completion of system upgrades and improvements (see enclosed consent decree).

The WWTP outfall and Manhole #1, where significant bypassing occurs, are both located in the upper reaches of Dry Auglaize Creek. There is no visible flow in the creek upstream of the WWTP outfall, except in wet weather, and the impaired section of the creek is considered effluent-dominated in most seasons. Although there are no other permitted facilities upstream of the WWTP, there is a small, unregulated dairy farm. The operation has a storage structure designed for 140 dairy cows (equal to 200 animal units), well below the 700-cow threshold to require a Concentrated Animal Feeding Operation (CAFO) State Operating Permit.

In the past, the department issued Letters of Approval (LOAs) to small, unregulated CAFOs who requested a review of their waste handling systems. On March 19, 2003, the department issued a LOA to this small facility in which it described acceptable procedures for them to store, treat and land apply dairy wastes.

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The Lebanon WWTP monitors Dry Auglaize Creek downstream from the dairy farm but upstream of their own outfall. Based on that monitoring, the city's wastewater superintendent believes that improvements in the dairy farm's waste handling methods are positively impacting the stream. There have been no discharges, no complaints about the facility and no violations cited since the new waste handling methods were implemented. The department has addressed the dairy as a possible source of stream impairment from nutrients, BOD and Total Suspended Solids (TSS) a term also used to reference NFR.

The department analyzed 34 water quality samples collected from Dry Auglaize Creek from September 1999 to August 2000 (see enclosed data). The analyses revealed that the stream met water quality standards for Dissolved Oxygen (DO) and that Carbonaceous Biological Oxygen Demand (CBOD) and Ammonia were not detectable. The discharge monitoring reports (DMRs) indicated that the WWTP met monthly limits of 10 mg/L for BOD and 15 mg/L for NFR in 1999 and 2000. However, the March and September 2000 biological assessment data (see enclosed report) collected by the department's Environmental Services Program (ESP), indicated that nutrients were high in the effluent-dominated stream and full protection of aquatic life was impaired when compared to reference streams.

Prior to the September 25, 2000 biological assessment sampling, the city was issued a Notice of Violation (NOV) for wastewater system bypasses that occurred on September 9, 10, 11, 12, 13 and 17, 2000. The significant impairment to aquatic life documented by the biological assessment likely resulted from the numerous bypasses of untreated wastewater two weeks prior to the biological sampling.

The August 17, 2000 report entitled "EPA Compliance Evaluation Inspection (Sanitary Sewer Overflows) at Lebanon WWTP," was completed in 2000 near the time of the water quality sampling. It identifies the impairment of aquatic life and the occurrences of excessive bypassing of untreated wastewater, particularly at Manhole #1 directly above the WWTP. The department's Water Protection Program observed bypassing at Manhole #1 on February 23, 2005, after only 0.3 inches of precipitation. The department's Southwest Regional Office (SWRO) collected, and had ESP test, numerous samples of bypassing flow at Manhole #1 and other system bypasses. Of the 13 samples analyzed from 1997 to 2002, BOD levels ranged from 211 mg/L to 48 mg/L, and NFR levels from 148 mg/L to 57 mg/L. In summary, the habitual bypassing of untreated wastewater to the creek from the collection system is well documented and appears to have an adverse effect on aquatic life.

The City of Lebanon is party to a consent decree (CD), signed in late 2003 and early 2004, with the Environmental Protection Agency (EPA) and the State of Missouri Civil Action No. 04-3125-CV-S-RED (copy enclosed). The CD requires elimination of bypassing from their collection system and construction of adequate system capacity by July 1, 2007. Elimination of bypassing should allow for wastewater to be treated at the WWTP before it is released to the Dry Auglaize Creek. Construction of corrective measures is currently underway. The CD has enforcement authority to ensure that the city will correct the bypassing and meet standards.

The city's state operating permit, issued September 29, 2006 (enclosed), has enforceable limits that address the WWTP discharge. The water quality standards for DO will be achieved by limiting the BOD to a weekly average of 15 mg/L and a monthly average of 10 mg/L. TSS limits are 20 mg/L weekly and 15 mg/L monthly. The interim Ammonia (NH_3 as N) daily maximum is 2.0 mg/L in summer and 3.0 daily maximum in winter. Final Ammonia limits that must be met in three years are 3.1 mg/L daily (1.6 mg/L monthly) in summer and 7.5 mg/L daily (3.7 mg/L monthly) in winter. Additional final permit limits include:

- Fecal Coliform daily maximum of 1,000 colonies per 100 ml (400 col/100ml average monthly),
- Bis (2-ethylhexl phthalate) limit of 0.006 mg/L monthly,
- Oil and Grease limit is 15 mg/L daily and 10 mg/L monthly,
- Copper limit is 0.021 mg/L daily and 0.01 mg/L monthly,
- Zinc limit is 0.192 mg/L daily and 0.089 mg/L monthly, and
- Phenols- monitoring only.

In-stream monitoring is required for NH_3 as N, Temperature, pH and DO.

The CD requires the city to complete construction of improvements to the wastewater collection system and provide adequate capacity in the system. This will improve the water quality for aquatic life in Dry Auglaize Creek. The CD gives EPA the authority to ensure the city will correct problems in the wastewater system. The department plans to conduct biological and water quality monitoring as deemed appropriate subsequent to completion of construction. The city's required WET tests and in-stream monitoring on Dry Auglaize Creek are delineated in their permit. In addition, a reopener clause was included to allow for stricter limits if future monitoring shows violations of Missouri's Water Quality Standards.

With this letter, the department submits the CD and the city's permit for concurrence that these documents will adequately serve in lieu of a TMDL on Dry Auglaize Creek. We appreciate EPA taking prompt action on this submittal. If you have any questions, please contact Ms. Donna Menown by telephone at (573) 526-1595, via e-mail at donna.menown@dnr.mo.gov, or by mail at Missouri Department of Natural Resources, Water Protection Program, P.O. Box 176, Jefferson City, Missouri 65102.

Sincerely,

WATER PROTECTION PROGRAM

Edward Galbraith
Director

EG:dml

Enclosures

c: Mr. Daniel R. Schuette, Director, DEQ
Mr. Earl Pabst, Deputy Director, DEQ
Missouri Clean Water Commission